



Clinical and health system factors associated with antiretroviral therapy adherence among people living with HIV and AIDS: cross-sectional survey insights from three ART facilities in Tamale, Ghana

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Abstract

Aim: Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) have attained a manageable chronic status as more infected people experience increases in their life quality and expectancy. Health system factors affect adherence to Antiretroviral Therapy (ART) among persons living with HIV (PLHIV). Nonetheless, literature on health-system factors and ART adherence among PLHIV is sparse. This study therefore aimed to elucidate clinical and health system factors associated with ART adherence among PLHIV in Tamale Metropolis.

Methods: We conducted a facility-based cross-sectional survey of 418 PLHIV in the Tamale Metropolis, selected by convenience sampling from three major ART centres. Each factor associated with ART adherence, considered statistically significant at a p -value of < 0.05 with a 95% confidence interval, was analysed using both binary and multivariate logistic regression. Adherence was assessed by self-report of missed doses in the past 30 days, categorised as good ($\geq 95\%$ of prescribed doses taken) or poor ($< 95\%$ of prescribed doses taken).

Results: The overall ART adherence rate was 93.1% (95% CI: 90.3%–95.2%). Clinical and health system factors significantly associated with higher adherence included the absence of post-pill fatigue (AOR = 0.09; 95% CI: 0.02–0.37), absence of complaints regarding pill size (AOR = 3.71; 95% CI: 1.23–11.18), lower cost of accessing therapy (AOR = 0.27; 95% CI: 0.10–0.73), uninterrupted ART supply (AOR = 7.76; 95% CI: 1.02–59.30), and strong social support systems (AOR = 6.62; 95% CI: 1.18–37.21).

Conclusions: An adherence rate of 93% was obtained which falls short of the 95% global benchmark. Clinical factors promoting adherence included the absence of fatigue and concerns related to pill size, while



health system-related factors promoting adherence included reduced cost of access, consistent ART supply, and good social support. The Ghana AIDS Commission and its implementing partners are urged to strengthen community-based social support networks, expand ART distribution points, and develop targeted educational initiatives to improve therapy adherence and contribute to achieving epidemic control. Limitations of this study include the use of self-reported adherence (potential recall and social desirability bias) and the cross-sectional design, which precludes causal inference.

Keywords

adherence, antiretroviral therapy, HIV&AIDS, Ghana, Tamale Metropolis, health systems

Introduction

It has been 30 years to date, after the 1996 introduction of the Highly Active Antiretroviral Therapy (HAART), Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) have become manageable chronic conditions as more infected people experience increases in the quality and expectancy of their lives [1, 2]. However, HIV and AIDS remain a paramount global public health challenge, with a worldwide imperative to eradicate AIDS and accelerate the HIV response by 2030 [3]. In 2021, the incidence of newly diagnosed HIV infections was 1.5 million, with 650,000 deaths attributed to AIDS, and an approximate total of 38.4 million persons living with HIV (PLHIV, 54% women and girls). Of these, 28.7 million (75% of PLHIV) could access ART. Despite efforts to curb novel infections and fatalities, Sub-Saharan Africa maintains the highest HIV prevalence globally, with approximately one in every twenty-five adults infected, constituting over two-thirds of all PLHIV worldwide. Moreover, the region is responsible for 45% of new HIV infections and half of all AIDS-related deaths globally [4, 5].

Adherence is defined as the degree to which a patient follows the instructions of a healthcare professional regarding prescribed medications [6]. Understanding the factors affecting PLHIV's effective and regular adherence to ART is crucial to addressing adherence which falls short of the 95% global benchmark adherence. Notable clinical factors include the use of traditional and herbal medicine, doubts concerning the benefits of ART, side effects, and the burden of pill consumption [7–10]. Health systems factors include discontentment with healthcare facilities and staff in particular, extended wait times, stockouts/shortages, distance, unforeseen facility charges, out-of-pocket expenses for medications and transportation to services, expenses of forgoing daily income-generating activities [7, 9, 11]. Studies conducted in Ghana that incorporated health system determinants of ART adherence have reported adherence rates of 51.2%, 44.6%, and 73%, respectively. Key factors associated with adherence that fall short of the 95% global benchmark include complex dosing regimens (i.e., more than one dose per day), the presence of treatment-related side effects, lack of regular reminders from healthcare providers, and long travel distances to ART centers, specifically distances of 51 kilometers or more [8, 12].

Ghana currently implements a triple therapy regimen for PLHIV, including either one nucleotide reverse transcriptase inhibitor (NtRTI), one nucleoside reverse transcriptase inhibitor (NRTI), and one integrase strand transfer inhibitor (INSTI) (primarily dolutegravir) as preferred first-line treatment for adults, or one NtRTI, one NRTIs, and one non-nucleoside reverse transcriptase inhibitor (NNRTI) (primarily efavirenz) as an alternative first-line option [13]. Ghana has an estimated 334,713 PLHIV as of 2018 with only 34% on ART, the country's HIV prevalence of 1.7% suggests a moderate HIV burden compared to several African nations. AIDS-related mortality in Ghana accounts for 14,181 deaths annually [14]. In Ghana's Northern region, HIV prevalence is 0.6%, affecting around 6,941 PLHIV. Tamale Metropolis contributes significantly, constituting 30% of the region's prevalence and achieving 88% ART coverage [15]. Studies conducted in Northern Ghana have examined ART adherence, but they have focused predominantly on individual or socio-cultural factors [16]. To our knowledge, no study in this region has quantitatively examined both clinical factors and health system factors within a single multivariable framework. This gap is significant because health system determinants are often modifiable through policy

and programmatic interventions, yet their relative contribution to adherence in Northern Ghana remains unquantified.

This study thus aimed to examine the clinical and health system challenges that PLHIV encounter in maintaining consistent adherence to their treatment regimen in the Tamale Metropolis. Objectives were to: (i) identify ART adherence rate and reported clinical and health system challenges; (ii) analyse associations between clinical and health system factors and ART adherence; and (iii) identify and prioritise actionable recommendations for healthcare providers, policymakers, and community organisations based on the strength of associations between modifiable factors and adherence. To our knowledge, no previous study in Northern Ghana has quantitatively examined both clinical factors and health system factors within a single multivariable framework.

Materials and methods

Study design and setting

We conducted a facility-based cross-sectional survey in three ART centres within Tamale Metropolis, namely Tamale Teaching Hospital (TTH), Tamale West Hospital (TWH), and Tamale Central Hospital (TCH). These facilities function as crucial referral points for the five northern regions of Ghana and neighbouring countries such as Togo, Ivory Coast, and Burkina Faso [17].

Study population

Eligibility criteria included PLHIV, aged 18 years or more, receiving ART at TTH, TWH, or TCH for at least six months, consenting to participate, and being in good physical/mental health, as determined through objective observation/interaction and a basic physical assessment. PLHIV experiencing critical clinical conditions during data collection or with speech or hearing impairments were excluded.

Sampling size determination

To estimate the desired effect and ensure the study was adequately powered, we calculated the sample size using the Cochran formula [18]:

$$n = \frac{z^2 \times pq}{d^2}$$

where z = reliability coefficient, d = margin of error, p = approximate percentage, $q = 1 - p$.

This calculation accounted for a reliability coefficient of 1.96, a 95% confidence interval (95% CI), and a margin of error of 5%, assuming an approximate percentage of 44.6% for PLHIV [8]. The estimated sample size was calculated using the following approach:

$$n = \frac{1.96^2 \times 0.446 \times (1 - 0.446)}{0.05^2} = 379.68$$

The resulting sample size was 380 participants. To address potential non-response, a 10% adjustment was applied (10% of 380 = 38), increasing the required sample size to 418 participants.

Sampling techniques and procedures

Three ART facilities (TTH, TCH and TWH) were purposively selected because they are the major referral hospitals within the Tamale Metropolis. Participants were then allocated to each facility using proportional allocation based on the formula: $n_i = (N_i/N) \times n$, where n_i is the number of participants sampled from facility i , N_i is the total number of eligible individuals at facility i , N is the total eligible population across all three sites, and n is the total sample size. This approach yielded 200 participants from TTH, 118 participants from TCH and 100 participants from TWH. Within each facility, convenience sampling was then employed to recruit participants who met the eligibility criteria. If a chosen individual declined to participate, another eligible participant was recruited in their place to ensure the target sample size was maintained.

Data collection

We adapted a questionnaire from various studies [8, 17, 19–23] and pre-tested with a convenience sample of 3 PLHIV at the TCH to ensure clarity and relevance. Topics included ART adherence (i.e., missed none, < 3 doses, 3–12 doses, over 12 doses), socio-demographics, clinical and health system factors with scaled responses (i.e., “Strongly Agree,” “Agree,” “Disagree,” “Strongly Disagree”).

Structured interviews were conducted by seven trained enumerators using a standardized approach. Each interview lasted a maximum of 45 minutes and took place between 27/11/23 and 20/02/24. To ensure consistency and minimize interviewer-related variability, all enumerators received the same training and followed a standard interview protocol. Enumerators were proficient in both English and Dagbani and translated questions as needed for participants who preferred Dagbani. Interviews were conducted in private rooms within each facility to guarantee privacy. Written informed consent was obtained from all participants, and confidentiality was maintained by assigning each participant a unique identification code; no personally identifiable information was collected. Data reliability and completeness were checked daily, and data were entered and coded using Microsoft Excel.

Analysis

Data were transferred to SPSS version 21 for analysis. The primary outcome variable was self-reported ART adherence, with a binary categorisation of ‘good adherence’ if participants reported taking at least 95% (i.e., missed none or < 3 doses) of their prescribed medication in the past 30 days or ‘poor adherence’ if they reported taking less than 95% (i.e., missing 3+ doses) of their prescribed medication in the past 30 days.

Independent variables were clinical or health system-related. These were recoded to facilitate binary logistic regression, with “Strongly Agree” and “Agree” taken as Agree, while “Strongly Disagree” and “Disagree” taken as Disagree. Descriptive statistics, including frequencies and percentages, were calculated for all variables to present a comprehensive summary of the dataset. To identify factors significantly associated with ART adherence, bivariate logistic regression was initially conducted. Variables achieving a significance level of 0.05 in the bivariate analysis were subsequently included in the multivariable logistic regression model to control for potential confounding factors. The variables included in the multivariable model were: fatigue, too many pills, pill odour, auditory hallucination, pill size, cost of accessing ART, social support, interrupted ART supply and cost of treating comorbidities. These variables were selected based on their significance in the bivariate analysis.

To ensure the validity of the responses related to variables influencing ART adherence, a pre-assessment of the internal consistency of the survey instrument was conducted using Cronbach’s Alpha analysis. This method assessed the reliability of participants’ responses across the 31 survey items. A Cronbach’s Alpha coefficient of 0.8 was obtained, demonstrating good internal consistency. This step, conducted before analyzing the data, confirmed the reliability of the instrument in capturing meaningful responses about ART adherence.

Results

Participant characteristics

Table 1 highlights the demographic profile of the 418 PLHIV surveyed, showing a predominance of females (73.2%; 95% CI: 68.7%–77.3%). The majority were between the ages of 30–49 years (56.5%; 95% CI: 51.7%–61.1%), married or cohabiting (64.4%; 95% CI: 59.5%–68.4%), Muslim (71.5%; 95% CI: 67.0%–75.7%), and of Dagomba ethnicity (64.6%; 95% CI: 59.9%–69.1%), reflecting the local socio-cultural landscape. Educational attainment was low, with about one-third (35.4%; 95% CI: 30.9%–40.1%) having no formal education, whilst the majority (73%; 95% CI: 68.5%–77.2%) lived in urban areas.

ART adherence

Table 2 shows that among the 418 PLHIV surveyed, 93.1% (95% CI: 90.3%–95.2%) demonstrated good adherence (defined as $\geq 95\%$ of prescribed doses taken in the past 30 days). The highest adherence was recorded at TTH (95.5%), compared to TWH (89%) and TCH (92.4%).

Table 1. Demographic characteristics of PLHIV on ART.

Variable	Tamale Central Hospital (n = 118)	Tamale West Hospital (n = 100)	Tamale Teaching Hospital (n = 200)	Total (N = 418)
Age groups				
18–29	25 (21.2%)	24 (24.0%)	51 (25.5%)	100 (23.9%)
30–49	72 (61.0%)	61 (61.0%)	103 (51.5%)	236 (56.5%)
≥ 50	21 (17.8%)	15 (15.0%)	46 (23.0%)	82 (19.6%)
Gender				
Male	28 (23.7%)	21 (21.0%)	63 (31.5%)	112 (26.8%)
Female	90 (76.3%)	79 (79.0%)	137 (68.5%)	306 (73.2%)
Marital status				
Married/cohabiting	72 (61.0%)	58 (58.0%)	139 (69.5%)	269 (64.4%)
Single	25 (21.2%)	32 (32.0%)	38 (19.0%)	95 (22.7%)
Widowed/divorced	21 (17.8%)	10 (10.0%)	23 (11.5%)	54 (12.9%)
Religion				
Islam	85 (72.0%)	79 (79.0%)	135 (67.5%)	299 (71.5%)
Christianity	33 (28.0%)	21 (21.0%)	65 (32.5%)	119 (28.5%)
Education Level				
No Formal education	43 (36.4%)	40 (40.0%)	65 (32.5%)	148 (35.4%)
Formal education	75 (63.6%)	60 (60.0%)	135 (67.5%)	270 (64.6%)
Settlement type				
Urban	79 (66.9%)	86 (86.0%)	140 (70.0%)	305 (73.0%)
Rural/subrural	39 (33.1%)	14 (14.0%)	60 (30.0%)	113 (27.0%)
Tribe				
Dagomba	80 (67.8%)	70 (70.0%)	120 (60.0%)	270 (64.6%)
Mamprusi	10 (8.5%)	3 (3.0%)	21 (10.5%)	34 (8.1%)
Others*	28 (23.7%)	27 (27.0%)	59 (29.5%)	114 (27.3%)

Others*: Mossi, Gonja, Frafra, Builsa, Waala, Kasina, Ga, Dagarti, Fante, Ashanti, Ewe, Hausa, Bimoba, Zabarma. Data were collected from three hospitals in the Tamale Metropolis (Ghana): Tamale Teaching Hospital, Tamale Central Hospital, and Tamale West Hospital. The study period was from November 2023 to February 2024.

Table 2. ART adherence rates.

Facility	Good adherence	Poor adherence	Total
Tamale Central Hospital	109 (92.4%)	9 (7.6%)	118
Tamale West Hospital	89 (89.0%)	11 (11.0%)	100
Tamale Teaching Hospital	191 (95.5%)	9 (4.5%)	200
Overall	389 (93.1%)	29 (6.9%)	418

Data were collected from three hospitals in the Tamale Metropolis (Ghana): Tamale Teaching Hospital, Tamale Central Hospital, and Tamale West Hospital.

Potential clinical factors affecting ART adherence

Table 3 shows that while 69% (95% CI: 64.6%–73.4%) of participants expressed preference for injectable ART, this finding does not directly predict adherence and requires further investigation. Most (57.9%; 95% CI: 53.3%–62.6%) also reported adhering to their ART regimen despite experiencing side effects.

Potential health system factors affecting ART adherence

Table 4 shows that most participants reported health system factors positively. For example, 91% (95% CI: 87.8%–93.4%) reported favourable health-worker influence, 95% (95% CI: 92.5%–96.8%) reported that health workers emphasized the importance of medication adherence, and 70% (95% CI: 65.5%–74.2%) received refill reminders. A little over 96% (95% CI: 92.5%–96.8%) reported not experiencing any harsh treatment, discrimination, or abuse at healthcare facilities. Most indicated ART services were always available and accessible (98%; 95% CI: 96.1%–99.1%), were confident in facility confidentiality practices (90.4%), and experienced financial (16.3%) and geographical (35.4%) barriers. Notably, only 22% reported

Table 3. Medication-related factors affecting ART adherence.

Statement	Frequency (n)	Percentage (%)
I take too many pills.		
Agree	49	11.7
Disagree	369	88.3
The pills are too big.		
Agree	163	39.0
Disagree	255	61.0
The smell of the pills puts me off.		
Agree	30	7.2
Disagree	388	92.8
I would prefer an injection instead of pills.		
Agree	290	69.4
Disagree	128	30.6
My energy is reduced/I feel fatigued when I take my ARVs.		
Agree	33	7.9
Disagree	385	92.1
I feel severe headaches when I take my medications.		
Agree	21	5.0
Disagree	397	95.0
When I take my medication, I experience preferences for certain food types.		
Agree	64	15.3
Disagree	354	84.7
Taking my ARVs makes me feel sick.		
Agree	23	5.5
Disagree	395	94.5
I hear voices when I take my ARVs.		
Agree	14	3.3
Disagree	404	96.7
I am faced with hunger and lack of food because ARVs make me have an increased appetite.		
Agree	180	43.1
Disagree	238	56.9
I lose my appetite when I take ARVs.		
Agree	21	5.0
Disagree	397	95.0
Taking ARVs has caused me to have lipodystrophy.		
Agree	13	3.1
Disagree	405	96.9
I experience nausea/vomiting when I take my ARVs.		
Agree	42	10.0
Disagree	376	90.0
I get diarrhoea when I take my ARVs.		
Agree	22	5.3
Disagree	396	94.7
I have trouble sleeping when I take my ARVs.		
Agree	29	6.9
Disagree	389	93.1
I feel numbness in my hands and legs when I take my ARVs.		
Agree	82	19.6
Disagree	336	80.4
I get rash or hypersensitivity when I take my ARVs.		
Agree	25	6.0
Disagree	393	94.0

Table 3. Medication-related factors affecting ART adherence. (continued)

Statement	Frequency (n)	Percentage (%)
I experience signs and symptoms of anaemia.		
Agree	19	4.5
Disagree	399	95.5
The duration and number of times I take my medications affect my treatment adherence.		
Agree	44	10.5
Disagree	374	89.5
I adhere to ART despite side effects.		
Agree	242	57.9
Disagree	176	42.1

Responses were binary (Agree/Disagree). ARV: antiretroviral

receiving social support from NGOs, welfare units, or volunteers. The highest negative response was 55%, who indicated that increasing patient numbers made it more crowded to access ART at their facility, hence impacting their adherence to therapy.

Table 4. Health system factors affecting ART adherence.

Statement	Frequency (n)	Percentage (%)
I was shouted at/treated harshly by healthcare providers.		
Agree	18	4.3
Disagree	400	95.7
Health workers took me through the importance of taking my medications.		
Agree	395	94.5
Disagree	23	5.5
I have a cordial relationship with my healthcare providers.		
Agree	382	91.4
Disagree	36	8.6
I experience discrimination and abuse in the healthcare unit.		
Agree	22	5.3
Disagree	396	94.7
I face high financial costs when accessing and receiving ART (e.g., transport, cost of drugs).		
Agree	68	16.3
Disagree	350	83.7
Interrupted ART supply from healthcare provider (e.g., due to a shortage of drugs and other commodities).		
Agree	34	8.1
Disagree	384	91.9
It takes lots of time for a refill of my medications (long waiting time).		
Agree	26	6.2
Disagree	392	93.8
I lose my income on ART therapy including treating underlying diseases/infections.		
Agree	12	2.9
Disagree	406	97.1
The distance from where I stay to the ART centre influences my adherence.		
Agree	148	35.4
Disagree	270	64.6
I get reminders from health workers for a refill (positive patient-provider partnership).		
Agree	292	69.9
Disagree	126	30.1
The ART services are always available and easily accessible.		
Agree	409	97.8
Disagree	9	2.2

Table 4. Health system factors affecting ART adherence. (continued)

Statement	Frequency (n)	Percentage (%)
I receive social support (e.g., from the welfare unit, government, NGO, volunteers).		
Agree	91	21.8
Disagree	327	78.2
There is a lack of confidentiality/respect for privacy at the facility.		
Agree	40	9.6
Disagree	378	90.4
The number of people accessing ARVs is always increasing at this hospital.		
Agree	230	55
Disagree	188	45
Health workers are very slow and not organized because when you come, no matter how early, you will still leave late.		
Agree	28	6.7
Disagree	390	93.3

Responses were binary (Agree/Disagree). ARV: antiretroviral

Clinical and health system-related determinants of adherence to ART

After adjusting for potential confounding variables using multivariable logistic regression analysis, several factors, as shown in Table 5, remained significantly associated with adherence to ART. These included both clinical and health system-related determinants. Clinically, the absence of post-pill fatigue and the lack of concern regarding pill size were positively associated with adherence. From a health system perspective, reduced financial burden, uninterrupted ART supply, and access to strong social support, whether from NGOs, government programs, or community networks, also significantly enhanced adherence.

Table 5. Determinants of adherence to ART among PLHIV.

Variables	Categories	<i>n</i> (%)	Test statistic (Bivariate)	COR (95% CI) (Multivariate)	AOR (95% CI) (Multivariate)
Clinical factors					
Fatigue	Disagree	385 (92%)	<i>p</i> = 0.024	0.14 (0.03–0.77)*	0.09 (0.02–0.37)*
	Agree	33 (8%)		Ref*	Ref*
Too many pills	Disagree	369 (88%)	<i>p</i> = 0.022	0.11 (0.02–0.65)	0.42 (0.12–1.51)
	Agree	49 (12%)		Ref*	Ref*
Pill odour	Disagreed	388 (93%)	<i>p</i> = 0.016	97.26 (2.32–4,075.16)	7.78 (0.66–91.35)
	Agreed	30 (7%)		Ref*	Ref*
Pill size	Disagreed	255 (61%)	<i>p</i> = 0.034	4.90 (1.12–21.22)*	3.71 (1.23–11.18)*
	Agreed	163 (39%)		Ref*	Ref*
Auditory hallucinations	Disagreed	404 (97%)	<i>p</i> = 0.015	0.04 (0.01–0.20)	0.30 (0.04–2.02)
	Agreed	14 (3%)		Ref*	Ref*
Health system factors					
High cost of accessing ART	Disagreed	350 (84%)	<i>p</i> = 0.031	0.22 (0.06–0.87)*	0.27 (0.10–0.73)*
	Agreed	68 (16%)		Ref*	Ref*
Social support	Disagreed	327 (78%)	<i>p</i> = 0.033	11.48 (1.22–108.51)*	6.62 (1.18–37.21)*
	Agreed	91 (22%)		Ref*	Ref*
Interrupted ART supply	Disagreed	384 (92%)	<i>p</i> = 0.028	15.88 (1.34–187.65)*	7.76 (1.02–59.30)*
	Agreed	34 (8%)		Ref*	Ref*
High cost of treating comorbidities	Disagreed	406 (97%)	<i>p</i> = 0.030	0.03 (0.01–0.18)	0.19 (0.03–1.4)
	Agreed	12 (3%)		Ref*	Ref*

Ref*: Reference; *: significant at $p < 0.05$; AOR (95% CI): adjusted odds ratio at 95% confidence level; COR (95% CI): crude/unadjusted odds ratio at 95% confidence level.

Specifically, participants who did not experience post-pill fatigue had 91% lower odds of non-adherence compared to those who did experience fatigue (AOR = 0.09; 95% CI: 0.02–0.37). In other words,

fatigue was a strong risk factor for suboptimal adherence. Similarly, individuals who reported no issues with pill size were 3.71 times more likely to adhere than those who found pill size problematic (AOR = 3.71; 95% CI: 1.23–11.18). For financial costs, participants who did not report high financial burden were 73% less likely to be non-adherent (AOR = 0.27; 95% CI: 0.10–0.73), indicating that cost is a barrier to optimal adherence. Moreover, ART supply was associated with a nearly eightfold increase in the odds of optimal adherence (AOR = 7.76; 95% CI: 1.02–59.30), the wide confidence interval for uninterrupted ART supply reflects the relatively small number of participants who experienced supply interruptions ($n = 34$). This estimate should therefore be interpreted with caution. Finally, strong social support was associated with a more than six-fold increase in the odds of optimal adherence (AOR = 6.62; 95% CI: 1.18–37.21). The combination of these five variables explained 16.4% of the variance in ART adherence (Nagelkerke $R^2 = 0.164$). The model demonstrated good fit to the data, as indicated by a non-significant Pearson Chi-Square test ($\chi^2 = 29.51$, $df = 22$, $p = 0.131$) and Deviance statistic ($\chi^2 = 24.45$, $df = 22$, $p = 0.324$), suggesting that the predicted values from the model do not significantly differ from the observed values, supporting the model's adequacy in explaining ART adherence behavior.

Discussion

This study is one of the first to explore the relationship between clinical and health system factors and ART adherence in Northern Ghana, offering vital contextual insights. The reported adherence rate of 93%, though encouraging, falls marginally below the 95% benchmark set by UNAIDS for achieving sustained viral suppression and halting the global spread of HIV/AIDS by 2025 [24]. Globally, ART adherence remains inconsistent, with reported rates ranging from 49% to 100% [25]. The adherence level observed in this study closely mirrors findings from Nigeria (92.6%) [26], suggesting some consistency in ART uptake across West African contexts. A 2024 systematic review of ART adherence in sub-Saharan Africa reported that overall good adherence rates ranged from 43% to 84% across the region, with West African countries specifically showing rates between 43% and 60% [27]. Our observed adherence rate of 93.1% is considerably higher than the West African regional average, suggesting that ART programmes in Northern Ghana may be performing exceptionally well compared to neighbouring countries. However, it contrasts significantly with lower adherence rates reported in other parts of Ghana such as the Sunyani Municipality (75%), Ga West Municipality (44.6%), and Cape Coast Metropolis (79.5%) [8, 16]. These discrepancies may reflect regional variations in health system capacity, socio-economic factors, and community engagement in HIV care. However, it is important to note that these are plausible hypotheses rather than empirically established explanations, as direct comparative studies across Ghanaian regions are limited. Nevertheless, previous reports from the Ghana Health Service have documented regional disparities in healthcare infrastructure, human resources for health, and funding allocations, which could contribute to differences in ART adherence outcomes [28]. The adherence rate observed in this study suggests that when adequately resourced and contextually adapted, ART programs in Northern Ghana can meet or approach global benchmarks. This reinforces the need to replicate and scale context-specific adherence strategies across regions with adherence which falls short of the 95% global benchmark.

We also note the predominance of female participants (73.2%) in our study sample. This pattern is consistent with national HIV epidemiology in Ghana, where women bear a disproportionate burden of HIV infection. According to the Ghana AIDS Commission, HIV prevalence among females (2.14%) was approximately 2.5 times higher than that among males (0.85%) [29]. Beyond epidemiological factors, socio-cultural dynamics in Northern Ghana may also contribute; women tend to access antenatal and reproductive health services more frequently, creating more opportunities for HIV testing and linkage to care. Additionally, gender norms that encourage women to prioritize family health may lead to greater healthcare engagement. These combined factors likely explain the overrepresentation of women in our study sample, which reflects the real-world demographic profile of PLHIV accessing ART services in the Tamale Metropolis.

Clinically, the study identified post-pill fatigue and pill size as significant barriers to adherence. While pill size is not a physiological side effect, it emerged as a perceptual barrier impacting patient motivation to maintain treatment regimens. These findings are consistent with earlier studies which highlighted how both physiological side effects and formulation-related inconveniences undermine adherence [21, 24, 30–31]. O’Connell et al. (2022) [24] and other studies [32–34] noted that the emergence of side effects during ART initiation is often associated with therapy interruptions, while Loveday et al. (2022) [21] emphasized that any adverse effect impairing a patient’s functional capacity poses a long-term threat to adherence. These findings highlight the importance of ongoing pharmacovigilance, patient-centered drug formulation (e.g., smaller or more palatable pills), and early side effect management. Health facilities should incorporate routine screening and counseling for side effects as part of ART adherence interventions.

Financial access was identified as a factor associated with adherence. Participants with reduced financial burden were 73% more likely to adhere to treatment. This aligns with findings by Loveday et al. (2022) [21], who emphasized the economic pressures such as employment retention and transport costs as barriers to ART adherence. These results reinforce the importance of policies that reduce out-of-pocket expenses, such as subsidized ART-related services or transport support. Financial protection mechanisms must be integrated into national HIV programs to improve long-term treatment retention.

Social support was shown to significantly enhance adherence, increasing the likelihood of consistent treatment by more than sixfold. This corroborates findings from prior studies which reported that peer groups, supportive families, and stigma-free communities are strongly associated with improved adherence outcomes [23, 26, 31, 35–37]. Conversely, social isolation or stigma can fracture critical support systems. HIV care programs must embed psychosocial interventions, including peer support groups and community sensitization campaigns into ART delivery models. Tailored support systems can buffer stigma and reinforce treatment commitment.

Health system functionality, particularly uninterrupted ART supply, also proved critical. Individuals with consistent access were 7.76 times more likely to adhere, echoing studies that have reported drug stock-outs, clinic appointment delays, and occupational conflicts as major adherence barriers [26, 35]. Strengthening ART supply chains and enhancing health facility responsiveness are non-negotiable. Integration of digital inventory tracking systems, improved staff capacity, and workplace flexibility policies for ART clients should be prioritized.

Collectively, these findings carry critical implications for clinical practice, health policy, and HIV program design. They underscore the need for comprehensive, multi-level interventions that address not only the clinical dimensions of HIV care but also the socio-economic and systemic determinants of adherence. Key strategies include ensuring the consistent availability of ART, minimizing patient costs, proactively managing side effects, and fostering robust community support structures. The involvement of civil society organizations, community health workers, and policy makers will be essential in translating these findings into sustainable programmatic improvements.

Limitations

This study offers important insights into ART adherence in Northern Ghana. The high response rate and consistent data collection procedures also enhance the reliability of the findings. Nonetheless, several limitations should be acknowledged. First, the study excluded individuals in their first six months of ART initiation, those who were critically ill, co-infected with tuberculosis, or with speech and hearing impairments. As a result, some unique adherence challenges experienced by these groups may not have been captured. Future studies should broaden inclusion criteria to reflect a more diverse patient population and ensure greater inclusivity.

Second, the cross-sectional nature of the study limits the ability to draw causal inferences between the identified factors and ART adherence. To better understand temporal dynamics and causal pathways, longitudinal and interventional studies are recommended. Third, although the study employed a consecutive sampling method, a non-probabilistic approach that limits generalizability, we mitigated

potential selection bias by recruiting participants systematically as they presented at ART clinics. Additionally, data collection across multiple health facilities with diverse demographics helped to improve representativeness and reduce the likelihood of sampling skew. Fourth, adherence was measured by self-report. Self-reported adherence is subject to recall bias and social desirability bias. Future studies should consider objective measures such as pill counts, electronic drug monitors, or pharmacy refill records to complement self-reports. Fifth, the pretest sample for questionnaire refinement was small ($n = 3$), which may have limited our ability to detect all ambiguous or confusing items. Sixth, variables for the multivariable model were selected based on bivariate statistical significance ($p < 0.05$). While this approach is common in exploratory cross-sectional studies, it may have excluded variables that are clinically important but did not reach statistical significance due to limited power or small subgroup sizes. Future studies should consider alternative variable selection methods (e.g., inclusion of all a priori clinically relevant variables) to reduce the risk of residual confounding. Because of the cross-sectional design, we cannot infer causality. All reported associations reflect statistical relationships at a single point in time and should not be interpreted as causal effects. Longitudinal or interventional studies are needed to establish directionality.

Despite these limitations, the study offers valuable baseline data and contextual evidence that can inform policy and programming efforts to improve ART adherence in similar low-resource settings.

In conclusion, this study identified a 93% ART adherence rate among PLHIV which falls short of the 95% global benchmark. Clinical factors promoting adherence included the absence of fatigue and concerns related to pill size, while health system related factors promoting adherence included reduced cost of access, consistent ART supply, and good social support. The Ghana AIDS Commission and its implementing partners are urged to strengthen community-based social support networks, expand ART distribution points, and develop targeted educational initiatives to improve therapy adherence and contribute to achieving epidemic control.

Abbreviations

AIDS: Acquired Immunodeficiency Syndrome

ART: Antiretroviral Therapy

HIV: Human Immunodeficiency Virus

NRTI: nucleoside reverse transcriptase inhibitor

NtRTI: nucleotide reverse transcriptase inhibitor

PLHIV: persons living with Human Immunodeficiency Virus

TCH: Tamale Central Hospital

TTH: Tamale Teaching Hospital

TWH: Tamale West Hospital

Declarations

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Author contributions

FGAS: Conceptualization, Methodology, Formal analysis, Data curation, Investigation, Writing—original draft, Writing—review & editing. UH: Conceptualization, Methodology, Validation, Writing—review & editing. AA: Writing—review & editing. GAA: Conceptualization, Methodology, Validation, Writing—review & editing. All authors read and approved the submitted version.

Conflicts of interest

The authors have reported no conflicts of interest.

Ethical approval

Ethics committees at the Tamale Teaching Hospital (reference TTHERC/20/11/23/01) and Ghana Health Service (GHS-ERC:053/09/23) provided ethics approval, respectively. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Consent to participate

Every participant in the study provided written, informed consent.

Consent to publication

Not applicable.

Availability of data and materials

Upon a reasonable request, the corresponding author can supply the data sets used in the current work.

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